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Real-Time Collaboration through the Cloud for Acute and Non Acute Medical Situations

Overview:

Nowadays, the sources and the typologies of medical knowledge involved in patient treatment and follow-up is growing exponentially, enabling us to boost the wellbeing and life expectancy of the Europe population. This growing knowledge comes hand in hand with high levels of specialisation and an increasing need for information about a patient's condition. In situations where the patient's life is at stake, the support of various specialist physicians is often needed and direct access to all relevant knowledge for that patient is crucial. The missing piece in the puzzle is an intelligent, virtual collaborative workspace so that physicians, wherever they are, can consult with each other, react to each other's diagnosis and come to a collective, responsible decision on the treatment, thus minimising the attendant risks for the patient.

The ITEA 2 MEDUSA project addresses these issues by linking the required levels of expertise within a virtual collaborative workspace for diagnosis and treatment with medical protocol support, in which quality, real-time availability and privacy protection are key features.

The MEDUSA project enhances the quality of diagnosis and decision - making in acute and/or critical situations in a patient's condition by introducing a new service concept in healthcare. This is based on three service pillars: advanced imaging, secure virtual workspaces and medical diagnosis support. Not only MEDUSA enhances the diagnosis of acute and chronic diseases leading to better and quicker treatments. It also streamlines the medical workflow and improves the cost efficiency substantially. It paves the way for new, commercial services in the European healthcare business by offering a combination of advanced real-time image processing, real-time decision support, new technologies for the exchange of massive data sets, and virtual collaborative workspaces.

The total cost for neurological and neurosurgical diseases (including direct medical costs and indirect productivity losses) in Europe is estimated at €92 billion each year. MEDUSA ambition is to decrease these costs by just 0.5%, thus ensuring potential savings to more than €40 million each year. Independent research studies conducted in six countries on avoidable medical examinations shows that between 6% and 18% of all patients experience multiple examinations. For trauma care, we face 38,000 patients each year, 20% of which require transfer to another hospital (7,600). If 12% of these patients received a double CT-scan that could have been avoided by MEDUSA, we would save 900 CT-scans with a cost of approximately €1,000 per scan. We could annually save €900,000 for trauma in these countries, not including costs for personnel etc. The market impact of MEDUSA is particularly relevant for healthcare stakeholders including hospitals, health insurers, medical systems manufacturers, systems integrators and communication providers. The MEDUSA industrial partners as well as the two start-ups created during the project will play an active role in this respect.

Functional breakthrough: intelligent, virtual, collaborative environment for medical purposes

The added value of a virtual collaborative environment can be illustrated through three use cases.

The first use case addresses acute trauma care, in which time and the immediate availability of specialised expertise are crucial. For an optimal treatment of trauma patients, it is very important to get the right patient in the right time to the right hospital. To reduce overtriage and undertriage and improve the quality and speed of diagnosis, instant collaboration is needed between ambulance personnel, physicians at nearby hospitals, and experts in specialised trauma centres. MEDUSA enables the remote collaboration and addresses the main bottlenecks in the current diagnosis process by offering real-time and continuous transmission of sensor data from the ambulance to trauma specialists in the hospital, real-time interpretation of these data to enable a more specific and objective diagnosis (based on legally approved medical protocols), secure and fast exchange of images, and advanced image processing as a service to regional hospitals.

The second use case concerns acute ischemic stroke, in which the rapidly developing loss of brain function is caused by a blockage of a cerebral artery. Here, consultation among a team of experts is made possible by MEDUSA through the use of remote collaboration technology. Furthermore, advanced image processing, which may not be available in work stations at the treating hospitals, is required to determine the optimal treatment. All image data, image data processing, and communications between the experts are made available by MEDUSA technology and can be accessed by authorised physicians in the specialist hospital.

The third use case is about cancer treatment, in which physicians collaborate in order to determine the patient diagnosis and plan the best treatment. One crucial step in radiation oncology treatment is the delineation of the areas to be irradiated (tumours) and to preserve organs at risk. This step involves the inputs of radiotherapists and nuclear medicine physicians, respectively specialists of anatomical and functional series, who possibly practice in different health centres. Thanks to MEDUSA, the experts can access remotely the contouring application, manage information from multi-modality imaging and collaborate in real-time on the patient case.

Additional use cases on virtual microscopy, post-traumatic coma assistance and cross-disciplinary medical meetings are also considered in the project.

Caption: MEDUSA virtual collaborative environment: an integrated and interoperable set of tools to unlock medical information and functionalities.

Technology breakthrough: A set of interoperable tools to unlock medical information functionalities

Advanced medical image processing as a service

The MEDUSA project provides solutions to on-demand, high-performance image processing. In 5 applicative scenarios, high-throughput processing tools have been developed and evaluated. All of these solutions share the common cloud-based framework. Furthermore, MEDUSA has compression-based techniques for optimized image transfer and image processing, in addition to advanced processing capabilities to extract required information from the images for optimization of treatment and clinical decision support. Examples include intracranial haemorrhage quantification, infarct volume detection, and tumour contouring for oncology. Furthermore, remote and high-performance analysis of in-vitro images has been implemented and validated. NICo-Lab, an AMC spin-off for automated Neurovascular image analysis supporting Multi-center Trials, has been created so as to leverage the market access for the MEDUSA cutting-edge research results.

Caption: Advanced medical imaging algorithms running inside the MEDUSA framework

Medical system end-to-end protection and defence

An overall security architecture meeting privacy requirements in virtual medical collaborative workspaces has been defined. It includes resources ensuring authentication, confidentiality, integrity, availability and content tracking. The main innovations are provided by (1) a Central IAM (Identity & Access Management) and firewall, (2) a multi-level encryption strategy, (3) traceability and integrity proof of technologies to medical uses.

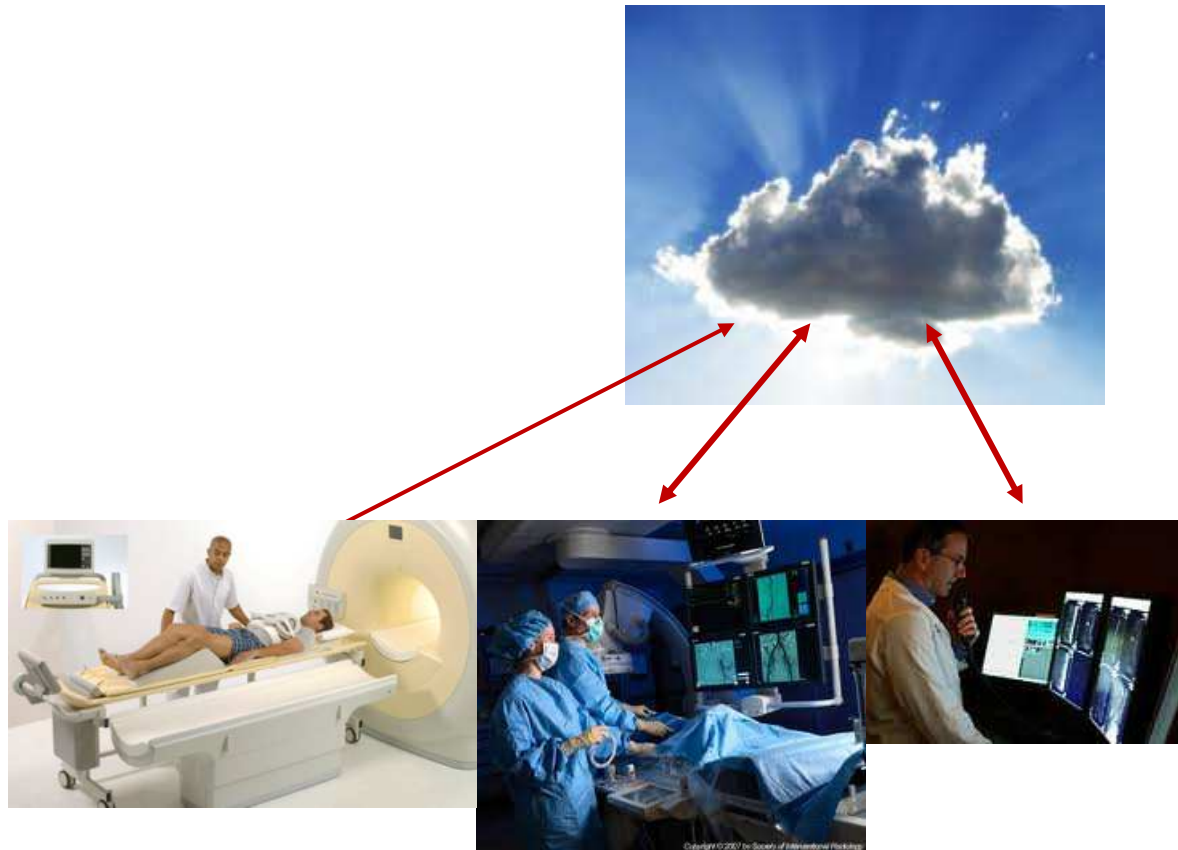*Cloud-based virtual collaborative framework*

Thanks to its architecture, infrastructure, support tools and functionalities, the MEDUSA virtual collaborative framework represents a true prime.

First, infrastructure components are deployed over high performance physical resources (computing, storage, etc.), thus providing the infrastructure as service (IaaS) relying on an open-source Cloud management system. This high performance realtime cloud allows the deploying and execution of application components with optimal performances, meeting the MEDUSA use cases and requirements.

This infrastructure benefits from meta-cloud deployment and management. Resources are allocated on this infrastructure through a cloud management platform, which handles their deployment, lifecycle management, monitoring, orchestration, and access in a dynamic, provider-independent way.

The collaboration functionality is offered, for the first time, as a service: it is no longer pre-programmed with the application but can be dynamically updated so as to take into consideration the actual working conditions, professional access rights, user privacy, etc.

Both legacy (mono-platform) and cloud-based applications can be deployed in the MEDUSA virtual collaborative space, thanks to optimized, cross-standard virtualization solutions. uStartApp, a spin-off from IMT, was created so as to offer to the market advanced cross standard solutions for building, in only 10 clicks, a SaaS offer around legacy medical applications.

Caption: Thanks to its scientific, technical and service innovations at the levels of architecture, infrastructure, support tools and functionalities, the MEDUSA virtual collaborative framework has been successfully validated by medical experts

Real-time decision support with sensors
The decision support functionality provides the doctors in a collaborative session with alerts about dangerous trends in a patient's condition. These trends are captured by sensors on the patient that are connected to the cloud through mobile applications to be interpreted in real time by rules as defined in approved medical protocols.